

4D Schedule Modeling—What Are the Advantages?

By William Cook, Vice President, URS Corporation

INTRODUCTION

“A picture is worth a thousand words”:

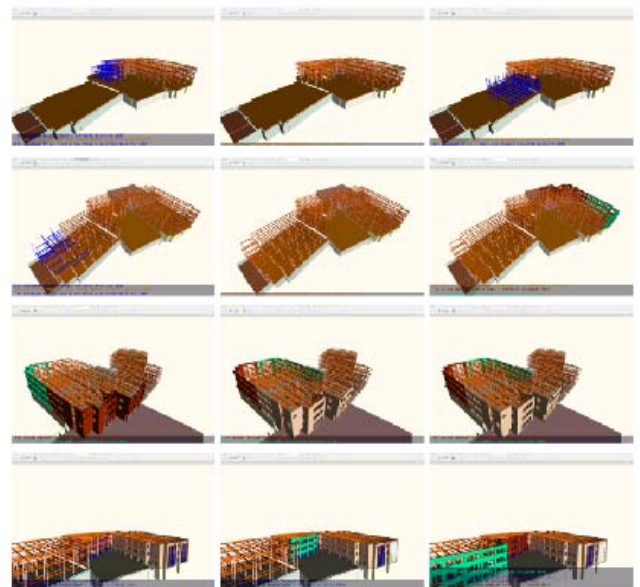
First the thousands words. We’ve all been there, staring at the latest schedule update plot. It fills half the wall, hundreds of horizontal bars in a multitude of colors. Microscopic print that even if you could read it would tell you that you’re “form rebar and pouring sequence 3, lift 4, northeast quadrant 4th Floor”. And I am sure, just as you are at that moment, that you are not exactly sure where that is, and everyone who is reviewing the schedule with you in the meeting is less sure than you. But now, after reviewing the schedule for several minutes, you’re sure you know exactly where that location is and the sequence of events that leads up to it and occurs subsequent to it. Then you make the fatal mistake of expounding upon your newfound knowledge only to find out that each person in the room has a different perspective of exactly where the pour is and the overall sequence of events after even though they have been looking at the same exact information you just did. And these are the people with some knowledge of what they are looking at. The rest of the room is filled with people who blindly nod their heads in agreement but have no idea of what they are looking at, what the horizontal bars mean, and why the ten minute discussion between the knowledgeable parties yields no consensus on what the schedule really illustrates.

And of course, all of this assumes that none of the leads and lags are actually shown on the schedule. If they were it would produce such a tangled web that no one could figure out.

Now the Picture. Imagine that each and every activity in that schedule not only had resources allocated to it, but also a three dimensional CAD representation of the exact work that was being performed. Moreover, that you could show this representation and one for every activity on every day of the project as a progressive video and every activity showing up as a discrete colored element in this video when it is being performed. After its completion, it fades into the background and forms the framework upon which new activities are highlighted, each in its proper sequence until the project is completed. Now, imagine that every time you update or modify the schedule that this video sequence of project activities is automatically revised, such that your new “picture” fully represents every activity as sequenced in the revised schedule.

Now let’s return to our scheduling meeting and instead of wasting half the meeting trying to figure out what the schedule is, telling everyone what your version is and dragging along those who can’t participate in the discussion, everyone can instantly and clearly see exactly what work is being performed, in what sequence and where it is. The focus of attention and discussion by **everyone** in the meeting is on the specific issues that need to be resolved and their potential impacts on the project.

A simple quantitative way to look at this benefit is to measure it during the review of a two-week look ahead schedule. Ten days or ten pictures at a thousand words



per picture produces ten thousand words that are saved. At a speaking pace of a one hundred words per minute (it makes the math easier) you've just saved a one hundred minutes of conversation. This may seem overly simplistic but having used 4D modeling for many years, it continues to demonstrate how much time is saved. Not to mention that you now have a more productive meeting for all in attendance immediately focusing on the issues and their resolution because everyone "can see it".

WHAT IS 4D SCHEDULING

The 4D Scheduling Model combines 3D CAD visualization with a fourth dimension -- time. A direct linkage is established between a 3D CAD model and the time sequenced construction activities in a computerized schedule. The tool as currently configured allows the viewer to see the construction from any point of view and watch it proceed as each successive element of work is performed day by day.

The current state-of-the-art software has been developed jointly by Stanford University's Center for Integrated Facility Engineering (CIFE) and Walt Disney Imagineering (WDI) Research & Development, Inc. and was initially utilized on Disney's California Adventure project. On California Adventure the overall master planning and phasing schedule had been modeled for one-third of the park, Paradise Pier, and a detailed construction model was created for the Seafood Restaurant.

The software and its development have evolved over the past several years and it is now known as InvisnOne owned by Common Point Technologies, Inc.

There are other 4D technologies emerging however, no other available modeling tool that I have seen provides the flexibility of the InvisnOne 4D tool and the ability to interface with any scheduling or CAD software.

The 4D tool allows for updating and modifying the schedule and the 4D model simultaneously. There are an unlimited number of attributes that can be assigned to each CAD element and the output is exportable to any other software for use in developing any type of graphic.

The advantages of using a 4D-scheduling model on any construction project are:

1. Clear communication of the sequence of construction to all project participants.
2. Early identification of problems virtually thereby avoiding costly field errors
3. Allows closer and more accurate coordination of trades at the subcontractor level to expedite construction, and manage and minimize risk.
4. Allows more accurate analysis of the impact of potential changes and the development of work around solutions to current construction issues.
5. Compare alternative schedule sequences visually and rapidly
6. Integrate cost and schedule information visually to better forecast and communicate estimate/cost
7. Mitigate schedule and project risk by effectively communicating the schedule and site logistics

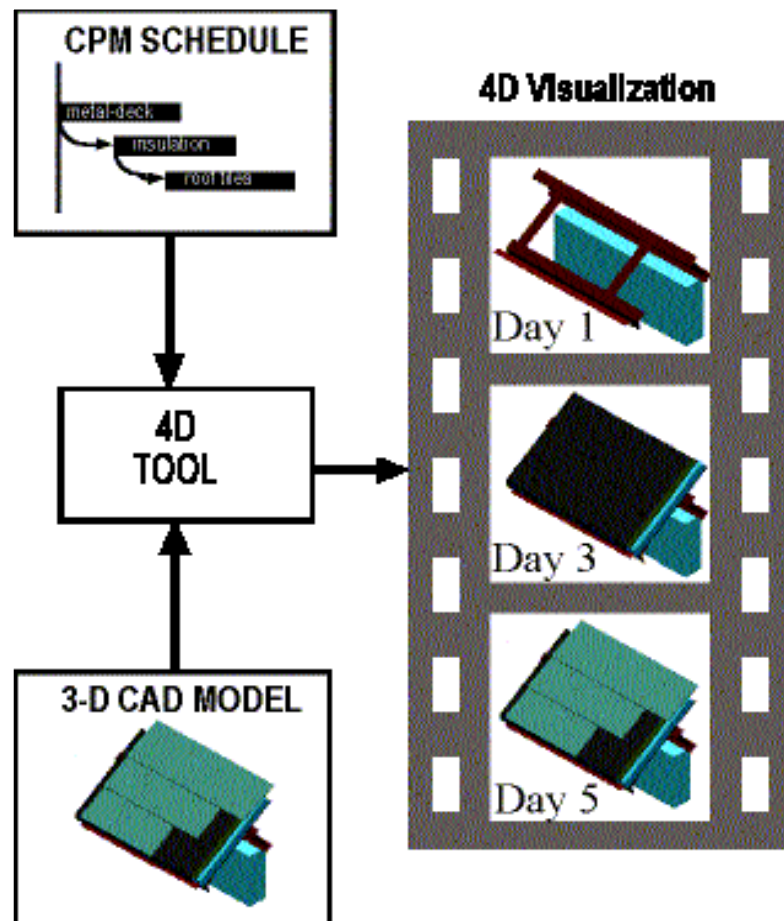
4D provides the ability for many people from different disciplines and with different expertise to see the project schedule in a common format that everyone understands – a three dimensional picture or “visualization” that also provides better analysis. communication

4D models enable a diverse team of project participants to understand and comment on the project scope and corresponding schedules in a proactive and timely manner. They enable the exploration and improvement of the project executing strategy, facilitate improvements in constructability with corresponding gains in on-site productivity, and make possible the rapid identification and resolution of time-space conflicts. 4D CAD models have proven particularly helpful in projects that involve many stakeholders, in projects undergoing renovation during operation, and in projects with tight, urban site conditions

The 4D tool produces an environment that supports hierarchical and interactive product and process modeling. This creates links between any level of detail of the models and the ability to easily group components by construction zones. This level of functionality allows the user to customize the content, view and level of detail for particular 4D visualization easily and quickly. The hierarchical representation of a design and construction schedule also allows users to update a 4D model efficiently because changes can be made at any level of detail.

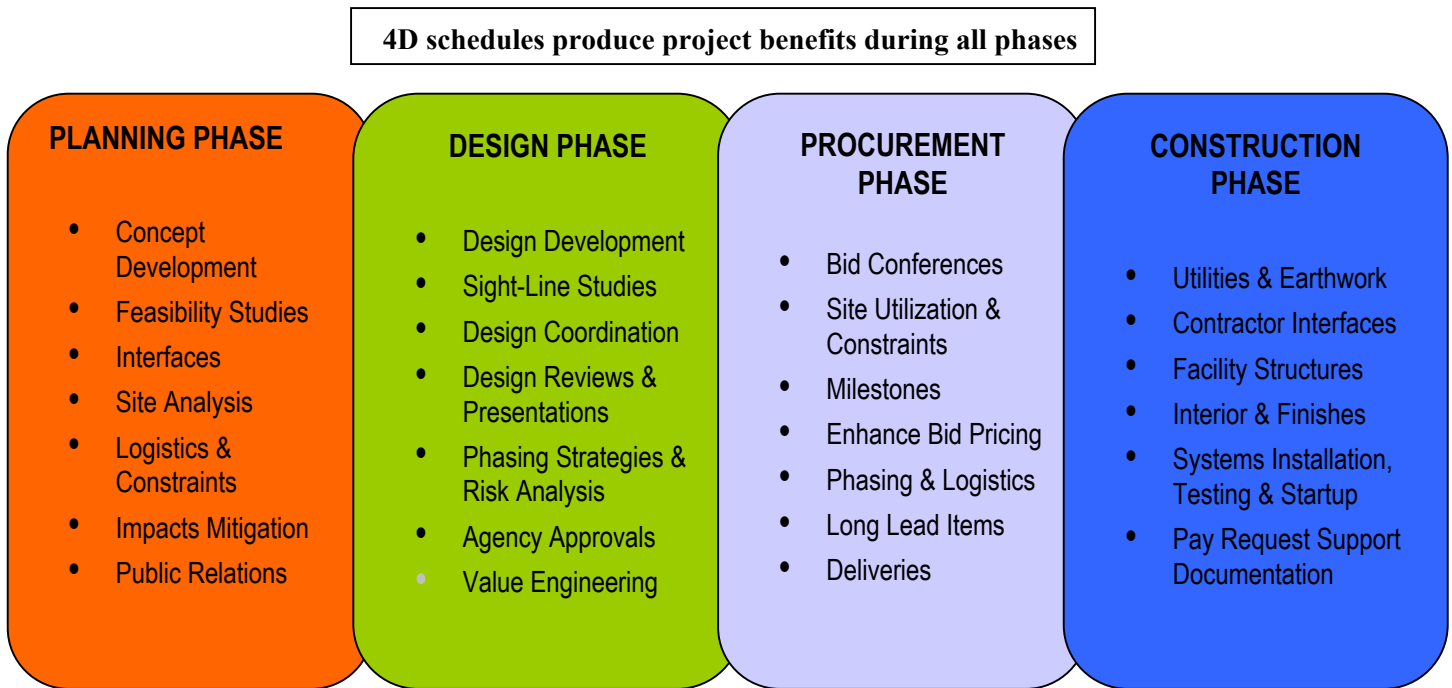
Through the use of the Internet multiple parties can create and view 4D models collaboratively, show 4D models to others as movies, and publish snapshots to illustrate milestones. Viewers on the Internet do not need to install new software because a web browser is all that is needed. On the desktop or on the Internet the user can change attributes, adjust visibility, select views and change the 3D model, schedule, and links between the 3D components and schedule activities in the 4D environment.

The graphic to the right visually represents how the 4D model is created by simply combining the 3D CAD information with the current scheduling data. As the schedule is revised and updated the visual representation is automatically changed to reflect the schedule changes.



USING 4D SCHEDULES

4D schedules can be developed at any time during a project and can be used to visualize construction, phasing, operational impacts, public interface and other project attributes as listed below. Any type of project will benefit from the use of a 4D schedule. However, the more complex the project or greater the number of projects within a program the greater the benefit that will be realized. Benefits can be achieved at various points within the development of a project as shown below.



During the initial project planning at Disney's California Adventure, lay down areas and construction zones were analyzed to minimize interference between contractors, while maximizing site utilization.

At the Santa Monica/UCLA Replacement Hospital, a portion of the existing was to be partially renovated and the remainder was to remain in operation while a new facility was being constructed around and through it. During the development of the data for the 4D model significant sequencing errors and omissions were discovered in the project phasing plans. The project phasing was spread through the:

- Original Hospital Phasing & Site Demolition Phasing Plans
- Demolition Plans
- Partial Floor Plans: Tower/Pavilion Connection
- Construction Sequence/Beneficial Occupancy Steps
- Hospital Interim Move List

As a result of developing the input data the overall project phasing was reworked before the 4D model had even been created. Once the model was developed studies were quickly and easily prepared to analyze alternative phasing plans to expedite overall schedule completion.

Currently on the Los Angeles County Hospital Seismic Retrofit Program, 4D schedules are being utilized on the three hospital projects. Each is being structural upgraded and the critical care areas are having all of the equipment and utilities seismically braced. The 4D models are being used to fine tune the detailed phasing plans being developed by the design teams. Perhaps more importantly, these schedules are being

used to meet with each of the affected departments to illustrate the sequence and duration of the impact of the work on their continually operational facility. More than half the construction cost is involved with the move management logistics as work progresses through all departments—sometimes room-by-room.

SAMPLE OUTPUT

To the right are three sample snapshots of the 4D program output. The same image and orientation are shown at three different times. If the program were actually running it would progress through the schedule as a video showing the work progress as it would be happening illustrating the sequenced in the schedule.

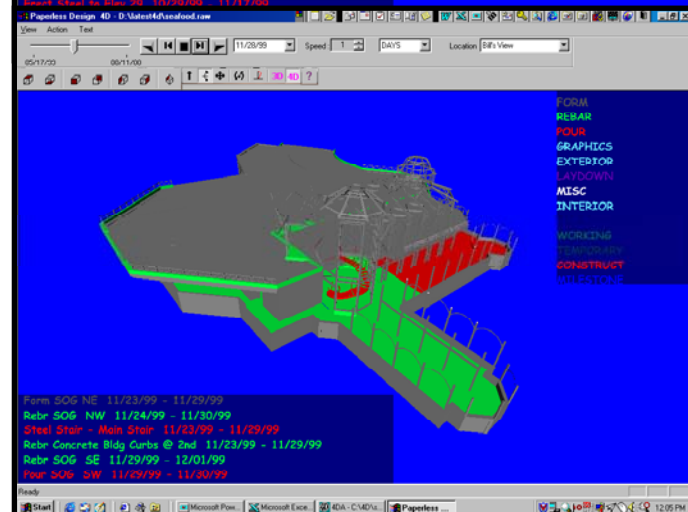
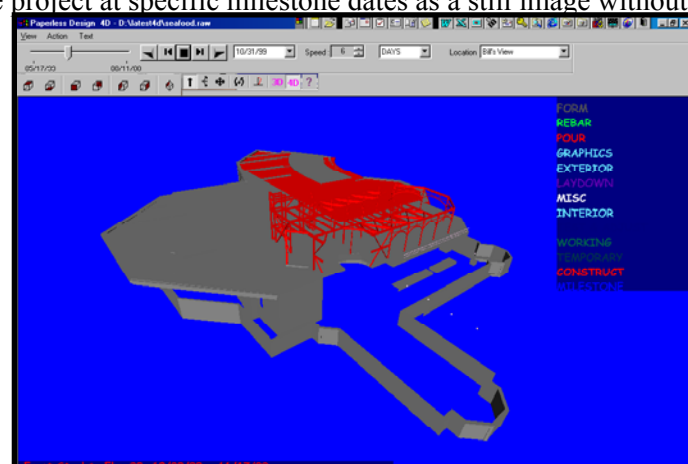
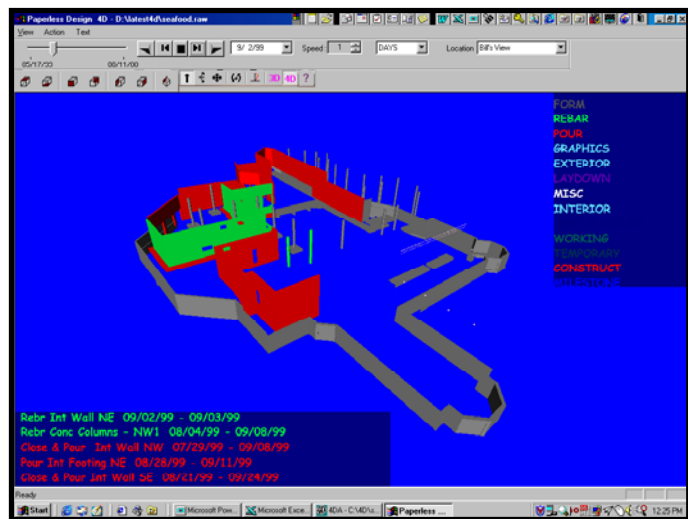
Orientation and view angle can be changed easily by using the pull down menus or establishing your own custom view of the model.

Using the pull down calendar you can view the project at specific milestone dates as a still image without the running video. At any time you can control the speed of the visual image by changing the number of days or hours that are shown per second. You can also advance the schedule one frame at a time or stop its advance at any time.

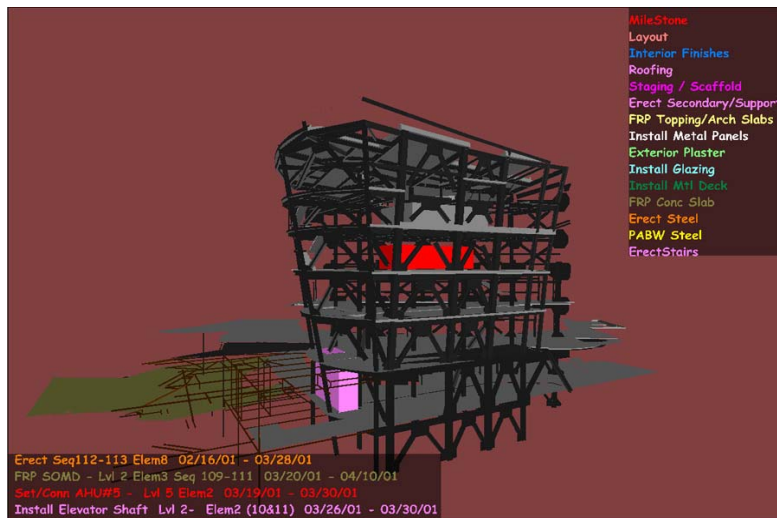
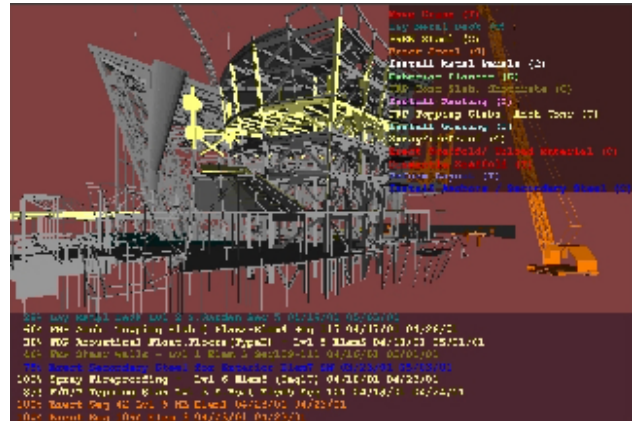
Along with the color-coded progress image the project color-coded schedule activities can also be made to appear. The activities currently being performed in the image are listed in the lower left corner. Thus the specific start and completion dates of work in progress in each image can be shown. This feature can also be easily disabled using the pull down menus.

Each of the physical elements in the CAD model can be assigned an unlimited number of attributes. The listing of attributes is also color-coded to match the work illustrated and the schedule activity. The attributes are shown in the upper right corner of the illustration. For example for the same wall element in a building different activities of work can be assigned at different times for: wall framing, electrical rough-in, drywall, painting and finishes. The same CAD element is used for each activity but the color is changed to coordinate with each specific activity of work.

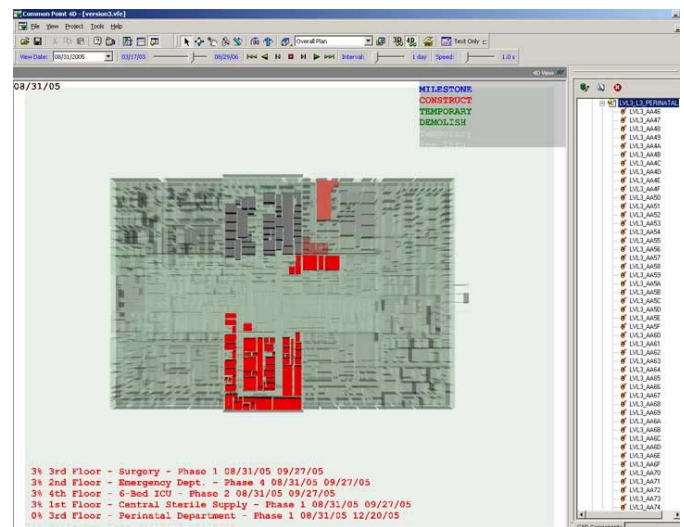
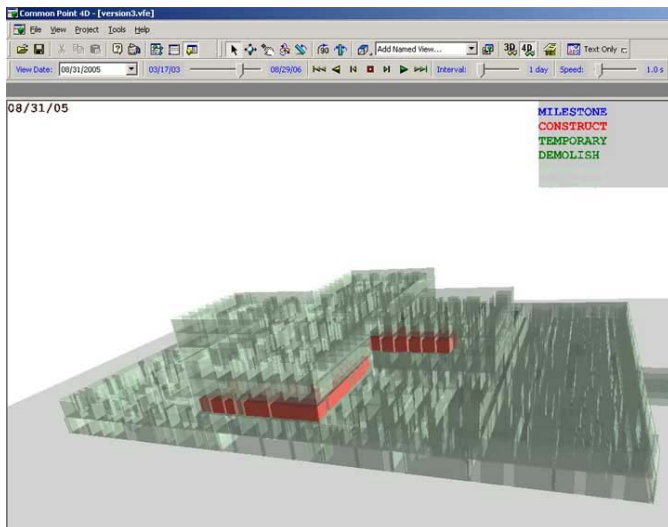
PROJECT MODELS

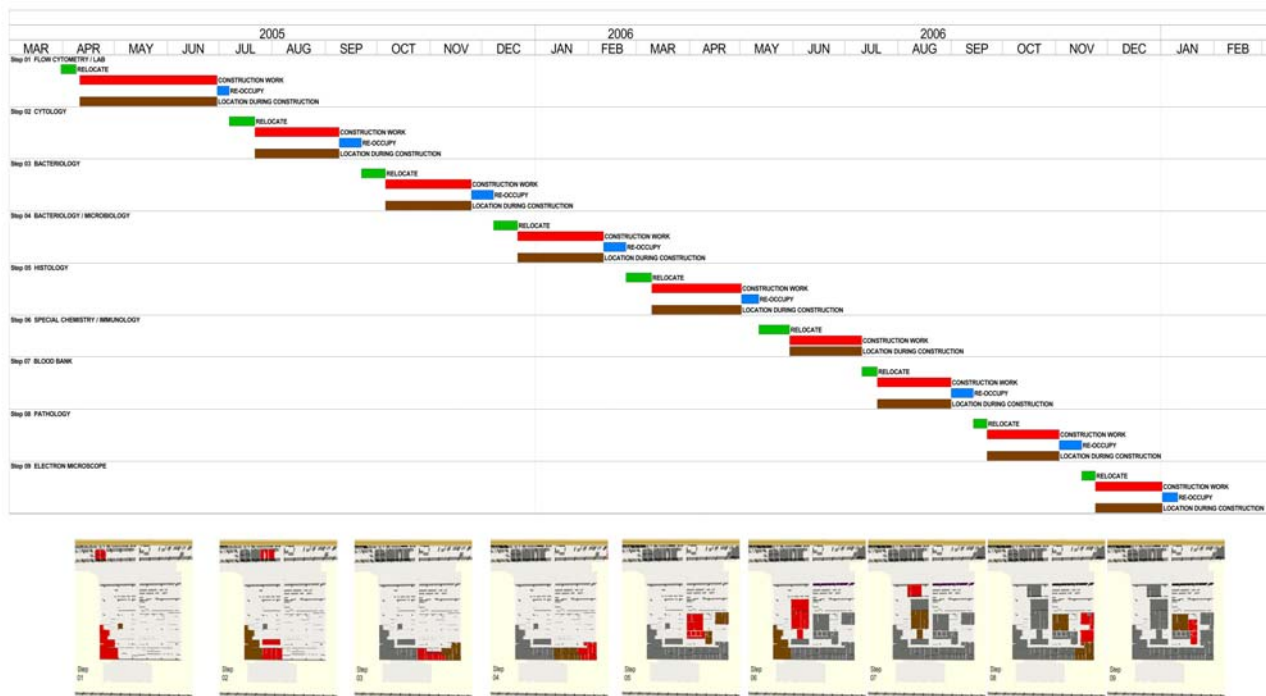


At the Walt Disney Concert Hall in Los Angeles the contractor used 4D schedules as the basis of their two-week look-ahead meetings with all of their subcontractors. Every major piece of structural steel was shown (of which no two pieces were parallel). Working on top of a previously constructed parking structure on a congested site all crane movements were also included in the model. Below the model revealed that the installation of an air-handling unit needed to be installed as the steel was being erected, not afterward as was originally scheduled (red box in center shows the air handler being installed after all of the major bracing steel was erected).



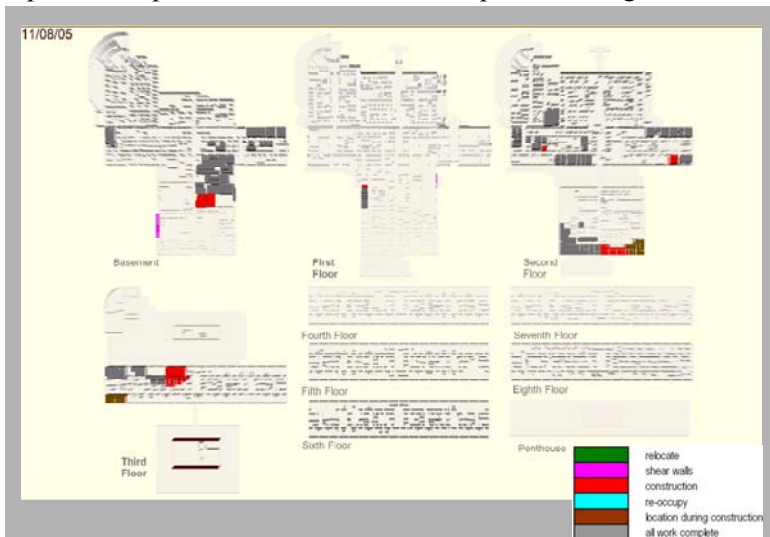
Illustrated below are both a full 3D version and a single floor of the Olive View-UCLA Medical Center, part of the Los Angeles County Seismic Retrofit Program. With the simultaneous work overlapping on multiple floors it became necessary to develop floor-by-floor views of the schedule. The same day and work is shown in both images.



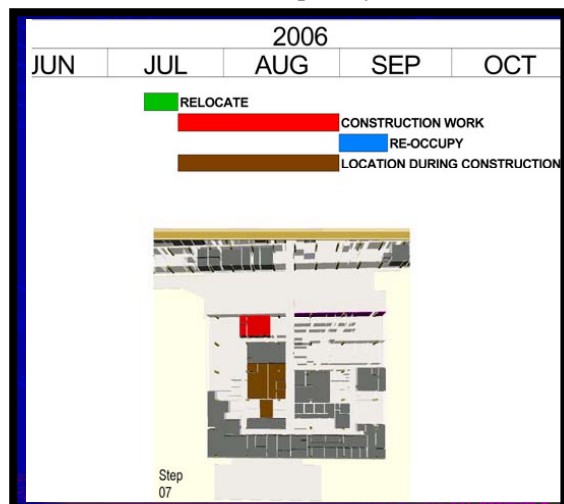


Harbor UCLA Medical Center is also part of the Seismic Retrofit Program. In addition to the typical output of a running video of the project (a snap shot of one day appears below showing all floor simultaneously) the hospital's facility staff requested a combined chart illustrating both the schedule time periods of performance and a location plan showing the affected areas (above). The one-day snap shot

illustrates all of the nine floors of the facility and the roof. A portion of this image at selected time intervals was used to create the combined chart for one department of the hospital.



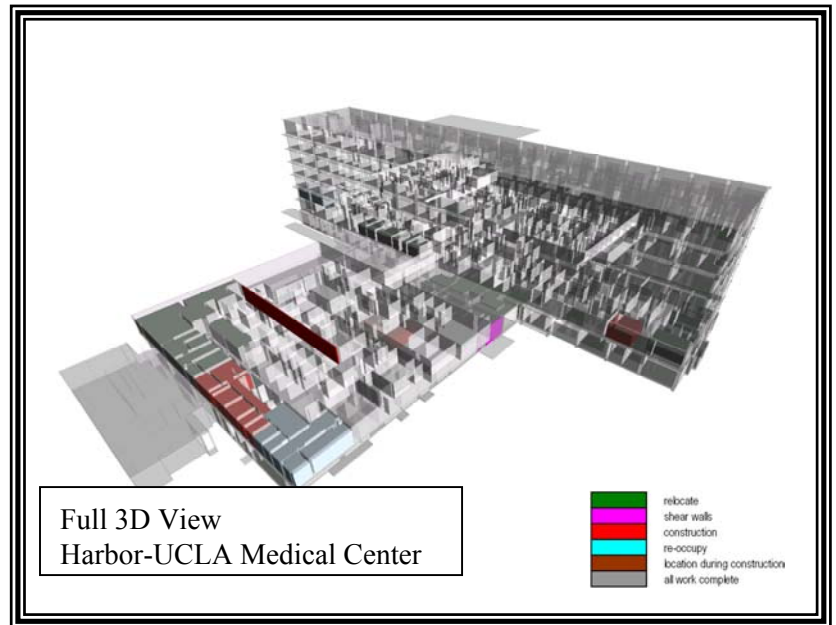
understandable to the key project stakeholder—the operations staff at the hospital. The image at the right is a blow-up of one step of the phasing of the work in this department.



SUMMARY

The ease of use, flexibility and compatibility with existing CAD and scheduling software of the 4D tool facilitates the use of the software on any project. On every project that it has been used its benefits were immediately recognized and continue to be identified.

Once the model is developed it is easily modified and updated with the importing of the schedule update data. When implemented during design, the development of the initial input forces the project planners to think about the process of construction and thereby see and resolve issues during the planning stage and incorporate the results into the bid documents



Enabling the project team to collectively view the future of any project gives them a breakthrough tool to see problems in a virtual environment before they are actually encountered and more importantly, develop solutions.

These pictures are worth more than a thousand words!

For more information feel free to contact Common Point Technologies directly at:

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